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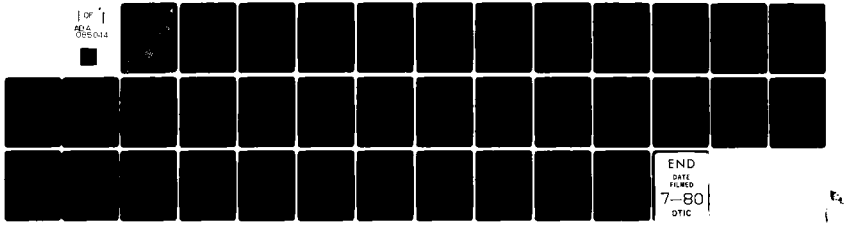

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SUPPLEMENT TO FINAL REPORT
SFD-261 CROSSED-FIELD AMPLIFIER
MANUFACTURING TECHNOLOGY PROGRAM

VARIAN ASSOCIATES, INC.
BEVERLY DIVISION
EIGHT SALEM ROAD
BEVERLY, MASSACHUSETTS 01915

16 MAY 1980

PREPARED FOR:

NAVAL REGIONAL PROCUREMENT OFFICE
LONG BEACH, CALIFORNIA 90801

NAVAL OCEAN SYSTEMS CENTER
271 CATALINA BOULEVARD
SAN DIEGO, CALIFORNIA 92152

varian-beverly

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KEY WORDS (Continue on reverse side if necessary and identify by block number)
MICROWAVE, AMPLIFIER, RADAR, ASSEMBLY, REPAIR, MACHINING, NUMERICALLY CONTROLLED, [illegible], SELF-JIGGING, PRECISION, REPAIRABILITY, [illegible] WIDE OUTPUT, EFFICIENCY, NOISE, PHASE.

ABSTRACT (Continue on reverse side if necessary and identify by block number)
The objective of the MT program is to establish high-yield production techniques by a pilot production run of ten tubes to meet performance specification and system compatibility criteria under production line conditions.

The SFD-261 is a microwave amplifier used to increase the power level [illegible] of energy by a factor of 20. It is used in the AN/SPY-1

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tube transmitter. A single ship's complement without spares is seventy six. The internal parts are made from high purity copper and many are complex and involve high precision. Most of the tube cathodes are [illegible] coated in hydrogen or in vacuum. Most production rates [illegible] to 30 units per month presently restrict the amount of automation which can be effectively applied.

Nearly 30 design changes were made without altering performance significantly. Self-jigging techniques permitted assembly by low skill levels. A "one-shot" vacuum braze for the cathode produced significant cost and component reduction. If the selling price of the standard design is normalized at 100, the price of the MT design is now 67. Because of the number of tubes per ship, with spares, the savings per ship will amount to $1 million.

REPORT 22-3040 FNL/SUPL

SUPPLEMENT TO FINAL REPORT

SFD-261 CROSSED-FIELD AMPLIFIER

MANUFACTURING TECHNOLOGY PROGRAM

VARIAN ASSOCIATES, INC.
BEVERLY DIVISION
EIGHT SALEM ROAD
BEVERLY, MASSACHUSETTS 01915

10 APRIL 1980

PREPARED FOR:

NAVAL REGIONAL PROCUREMENT OFFICE

LONG BEACH, CALIFORNIA

NAVAL OCEAN SYSTEMS CENTER

271 CATALINA BOULEVARD

SAN DIEGO, CALIFORNIA 92152

Table of Contents

1.0 INTRODUCTION

The SFD-261MT (Manufacturing Technology) program was completed in mid 1979 with an End-of-Project Demonstration conducted at Varian/Beverly on 31 May 1979, and delivery of the ten crossed-field amplifiers produced on the program was made to the Naval Weapons Support Center/Crane (NWSC) in June 1979. There the tubes were to be subjected to a variety of qualification tests to establish the design as a candidate for use in the AN/SPY-1 radar of the Aegis weapon system, where the economies realized in the MT design were to produce the pay-back to the Navy of the MT program. During the conduct of shock qualification tests at NWSC, some failures occurred which cast some doubt about the mechanical integrity of the MT design. The doubt was serious enough to prevent the acceptance of the design in the CG-48, production contracts for which were to be placed with Varian in March 1980.

The purpose of this supplement is to report on those events at NWSC/Crane, the findings regarding the failed tubes by Varian, and the corrective measures which were taken.

2.0 QUALIFICATION TESTING BY NWSC/CRANE

The serial numbers of the eleven MT tubes delivered are shown in the tabulation below:

I343V	K332V	A453W
I414V	K363V	B3W
K180V	L1V	B102W
K185V	L74V	

The eleventh tube, L1V, was delivered to the CSEDS site at RCA/ Moorestown where it was installed in a driver/pre-driver operating socket. It was not part of the qualification test sample sent to NWSC/Crane.

Two of the ten tubes at Crane were put on operating life tests, serial numbers I414V and B3W. One tube was put on shelf life test, number K185V. The remaining seven tubes were available for shock and vibration testing.

The first tube to be shock tested, S/N K180V, was subjected to a shock of 120 g's (versus 50 g's of the specification) and was mounted in the test fixture with only four of the six normally used mounting screws. The tube failed mechanically and electrically: mechanically because some screws holding the magnetic return path together were sheared; and electrically because the resulting degaussing of the magnetic circuit prevented normal operation. The applied shock was along the cathode axis in a direction from the cathode toward the high voltage bushing.

The second tube to be shocked, S/N A453W, was mounted with all six screws in the test fixture and passed the 120 g shock tests along the cathode axis. It failed later, however, when it developed a Vac-Ion pump short circuit after a 75 g shock transverse to the cathode axis. Varian requested that Crane start out with shock tests at the 50 g specification level before proceeding to higher levels.

Three additional tubes were shock tested, S/N's K332V, L74V and B102W. In all three tests there were indications of change in the RF operation (mainly in a downward shift of the operating voltage and reduction of output power), but in only one tube, S/N K332V, did the RF power change exceed the 0.4 dB allowed by the specification. Nevertheless, there were indications that parts of the mechanical assembly had shifted as a result of the shocks. Small cracks appeared in the seams of epoxy adhesives used in the assembly procedure.

Crane then subjected two SFD-261H tubes from current production (contract DLA900-79-C-1652 with Defense Electronic Supply Center) to the same shock tests (50 g's, 11 ms) and they passed without change. This suggested the possibility of differences between the SFD-261H and SFD-261MT assembly procedures, because the magnetic package designs of the two are equivalent.

3.0 MECHANICAL EVALUATION AT VARIAN

All five of these tubes were returned to Varian, who also asked for the return of the remaining two tubes, I343V and K363V, which were not occupied in either operating or shelf life testing. The plan was for Varian to examine all seven tubes to determine if there were any differences of significance in the mechanical assemblies or assembly procedures between the SFD-261H and the SFD-261MT. For this examination, Varian set aside numbers K180V and A453W on the basis that they had either been improperly mounted for test, or tested beyond the 50 g qualification level, or both.

Tube numbers K332V, L74V and B102W were mechanically disassembled, separating the high vacuum seal assembly from the magnetic circuit and other parts. Mechanical engineering representatives of NWSC observed the disassembly. A number of obvious discrepancies were found which explained why these tubes were more fragile than the SFD-261H, the discrepancies being purely procedural and not a matter of design:

3.1 Epoxy used between transformer and grooves in mounting plate was improperly applied.

3.2 Epoxy used between magnet and end plate, magnet and body assembly, and magnet and mounting plate assembly was inconsistently applied from tube-to-tube.

3.3 No body support segments were used on L74V.

3.4 Other discrepancies were noted which did not particularly affect the mechanical integrity of the tubes.

The remaining four tubes were also disassembled and six of the seven tubes were reassembled in strict accordance with the procedures used for the SFD-261H. The seventh tube, A453W, was damaged beyond repair by accident during the separation of the cathode/stem pole piece assembly from the body waveguide assembly. (Fixtures are being modified to prevent a recurrence of such damage.)

4.0 Revaluation of the Tubes

All six tubes were tested to either the A-1 or R-1 procedure to provide baseline data before the conduct of shock tests by Varian. Tubes K332V, L74V and B102W were delivered to Acton Environmental Testing Corporation for shock testing. Each tube was subjected to 18 shocks of 47 g's, 9.5 milliseconds duration, half sine shape--3 shocks in each of 6 axes. A copy of their report is attached as Appendix I. The baseline tests were repeated after shock testing. The largest deviation in power output performance was -.18 dB on B102W compared with an allowable change of -0.4 dB.

Shock tests were successfully conducted by NWSC on I343V and K363V, both of which had never undergone shock testing.

5.0 CONCLUSIONS

Assembly of the MT tubes into the permanent magnet package had not been originally carried out in accordance with the prescribed assembly procedures and, as a result, the tubes did not have the mechanical integrity they were designed to have.

Reassembly in accordance with procedures did restore mechanical integrity, as demonstrated by the successful testing of seven tubes:

Two (2) SFD-261H tubes by NWSC.

Three (3) SFD-261MT tubes by Varian.

Two (2) SFD-261MT tubes by NWSC.

Evidence of shifting parts, given by cracks in epoxy adhesive, was no longer observed.

By mid March, life test data on the tubes at Crane was favorable and this together with a resolution of the shock test problem enabled a recommendation to be made by NWSC for the use of the SFD-261MT for the CG-48. Varian is now under contract to produce tubes of the MT design for Aegis.

APPENDIX I

REPORT OF TEST ON...

SHOCK TESTING OF MODEL SFD-261
CROSSED-FIELD AMPLIFIER FOR
VARIAN ASSOCIATES, INC.

BY...

ACTON ENVIRONMENTAL TESTING CORP.

JANUARY 15, 1980

ACTON ENVIRONMENTAL TESTING CORPORATION

REPORT

Put us to the test.

Test Report No. 15366 No. of Pages 22

Report of Test on

SHOCK TESTING
OF MODEL SFD 261 CROSSED FIELD AMPLIFIER
FOR VARIAN
UNDER PURCHASE ORDER NO. 64697-E5

ACTON ENVIRONMENTAL TESTING CORPORATION

Date January 15, 1980

	Prepared	Checked	Approved
By	A.LeBourdais	M.Casaubon	M.L.Tolf
Signed	A. LeBourdais	M. Casaubon	M. L. Tolf
Date	1/15/80	1-15-80	1/15/80

AWL/hmf

Administrative Data

1.0 Purpose of Test: To subject crossed field amplifiers to shock exposures.

2.0 Manufacturer: Varian

3.0 Manufacturer's Type or Model No: SFD 261 Crossed Field Amplifier

4.0 Drawing, Specification or Exhibit: Per Varian representative's instructions.
(See requirements herein).

5.0 Quantity of Items Tested: Three (3)
S/Ns L74V(MT), K332V(MT), B102W(MT)

6.0 Security Classification of Items: Unclassified

7.0 Date Test Completed: December 28, 1979

8.0 Test Conducted By: J.Martens

9.0 Disposition of Specimens: Returned to Varian.

10.0 Abstract: Evaluation of the crossed field amplifier during and after shock exposures was made by Varian representative.

1.0 REQUIREMENTS

Each of the crossed field amplifiers shall be subjected to a shock test whose magnitude is 47g's, 9.5 milliseconds duration, one-half sine-wave shape. Each amplifier shall be subjected to 18 shocks; 3 shocks in each direction in each of 3 mutually perpendicular axes.

2.0 PROCEDURES

The crossed field amplifiers were shock tested individually. The amplifiers were mounted to a test fixture furnished by Varian which in turn was secured to the exciter of the vibration system. The vibration system was programmed utilizing the control computer to perform the required half-sine shock test.

Following setup, each of the units was subjected to the required 18 shocks. The control accelerometer outputs generated during each three groups of shocks are included with this report.

During test, the amplifiers were non-operating.

3.0 RESULTS

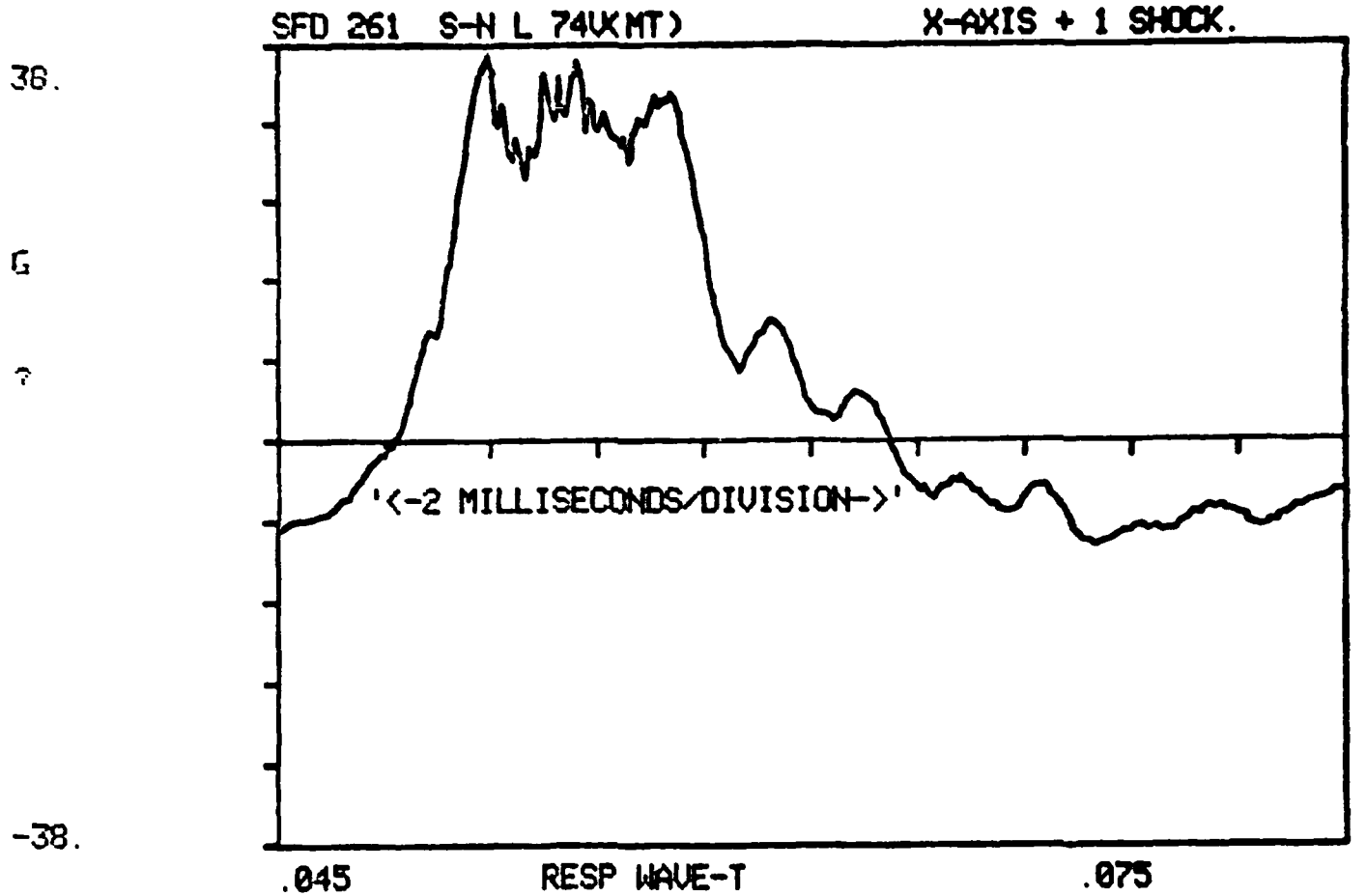
Evaluation of the crossed field amplifiers during and after testing was made by Varian representative.

15366

Report No. _____

TEST EQUIPMENT LIST

NAME	MFGR.	MODEL	SER.NO.	RANGE	ACCURACY	INV.#	CAL.FREQ.
Amplifier	Ling	CP10/16VC	41914	5 Hz - 5 KHz	+5%		
Exciter	"	A300	59	6000# force 1" P/P disp.	±2%	PE314	1 month
Exciter	Ling	A249	70	30,000# force 1" P/P Disp.	+5%		
Amplifier	"	PP120/150	56	5 - 5 KHz	±2%	PE317	1 month
Digital Controller	Time Data	TDV-20		70 db voltage DC-6 KHz	±1db	PE392	when used
Power Supply 6 channel	PCB	483A02	396	+22 VDC 4 MA constant per channel	N/A	PE305	6 months
Accelerometer	PCB	302A	2855	1 Hz - 5 KHż	±5%	AC410	6 months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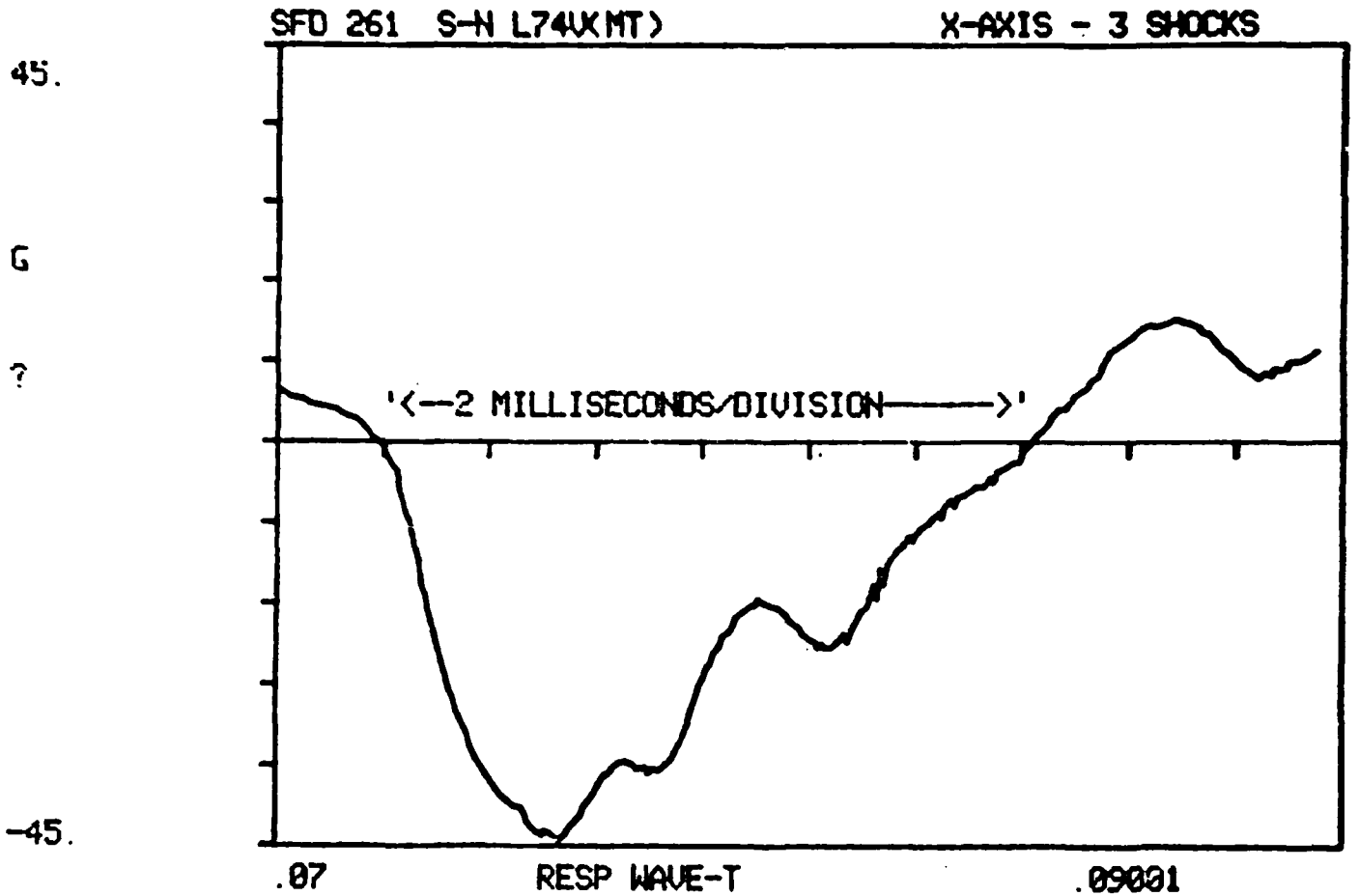
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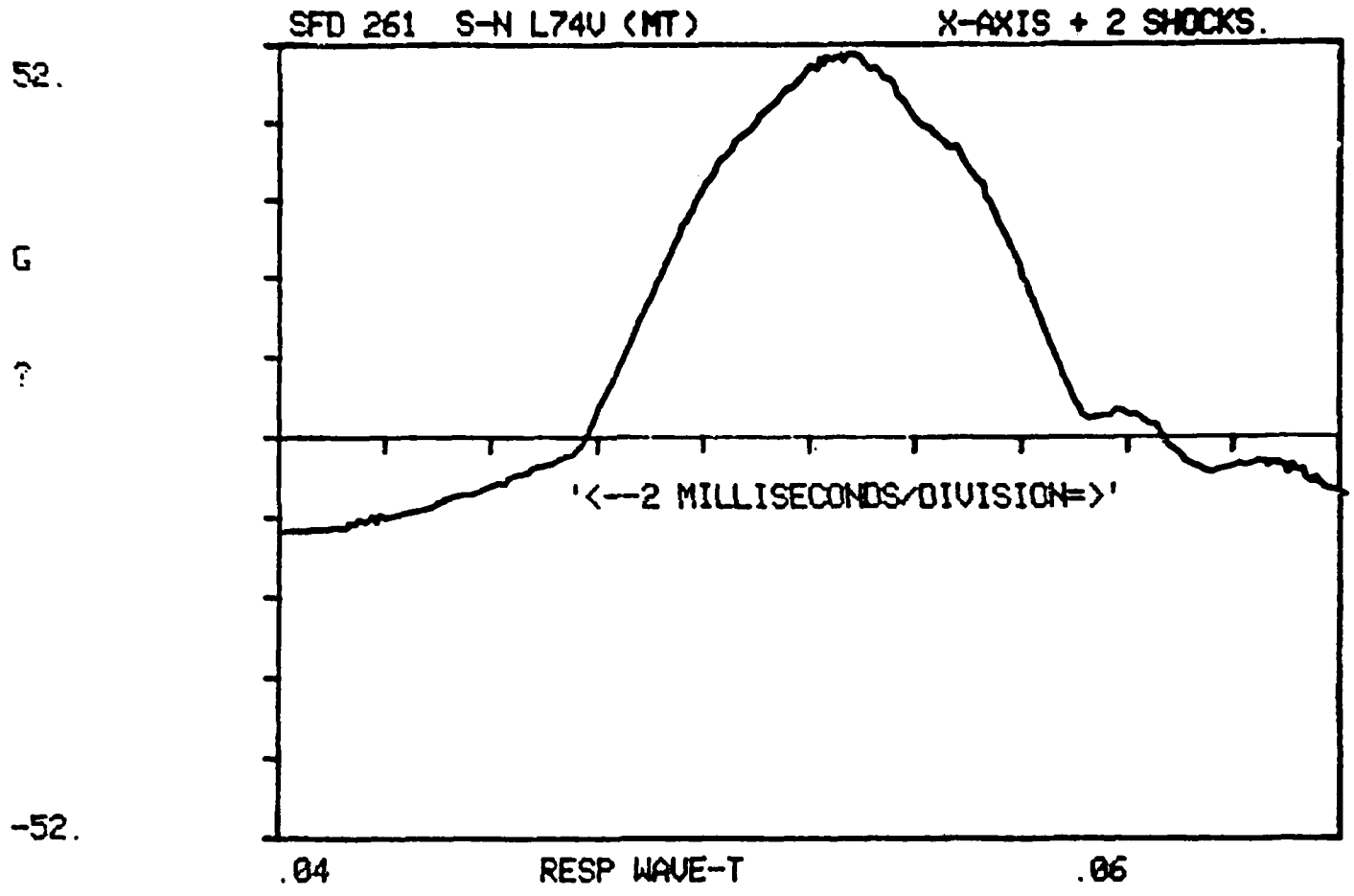
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RESP WAVE-T
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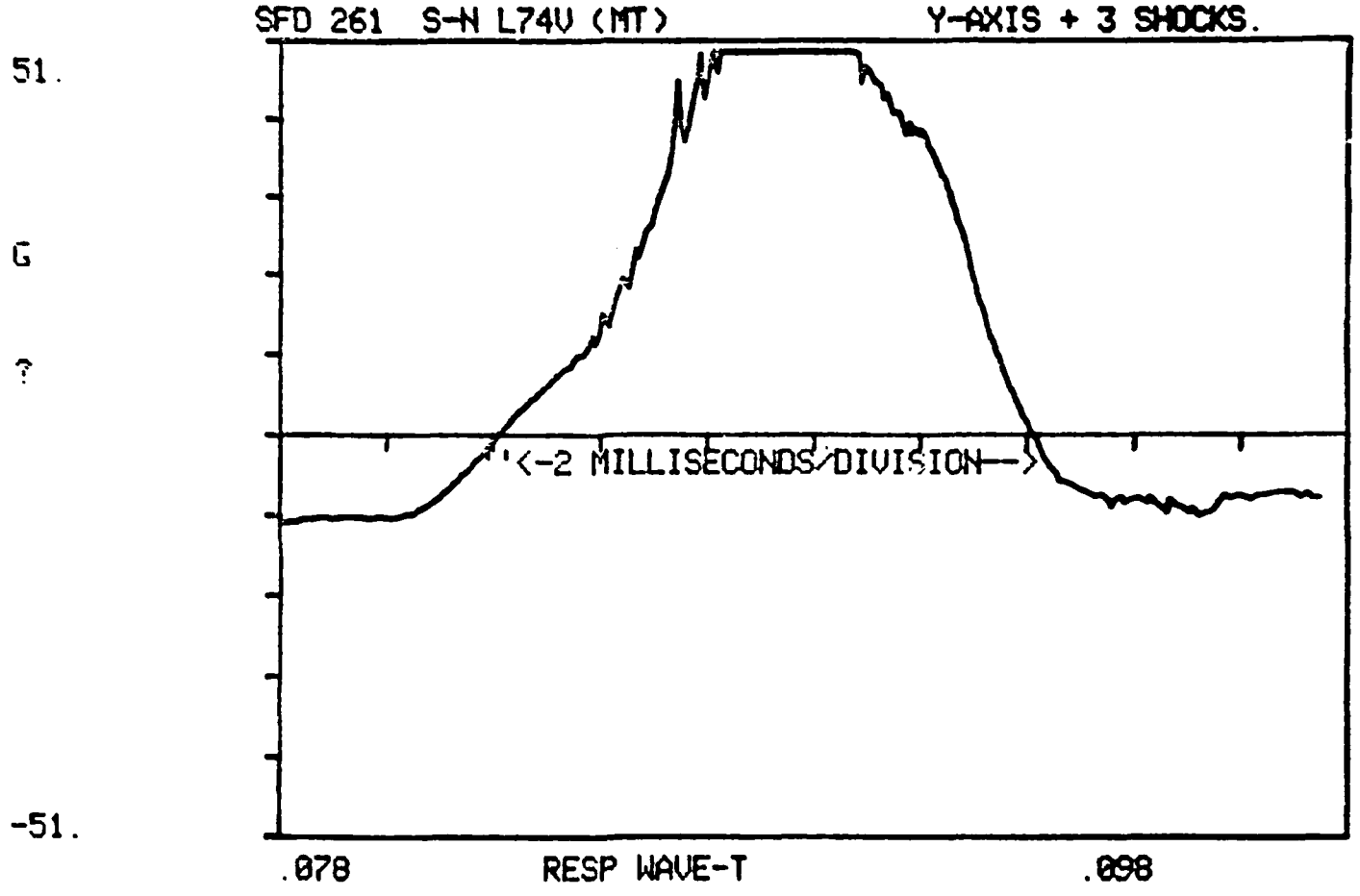
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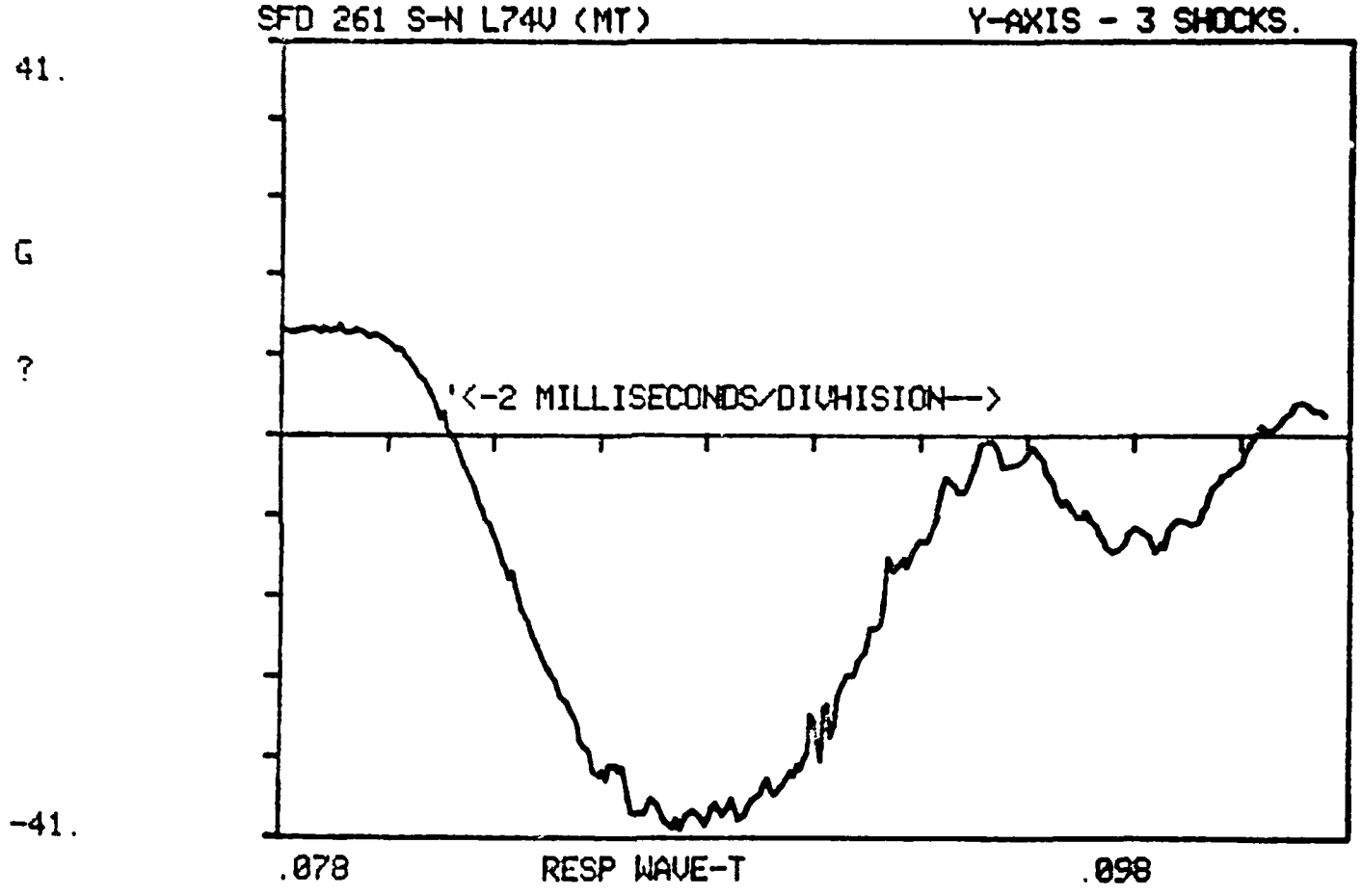
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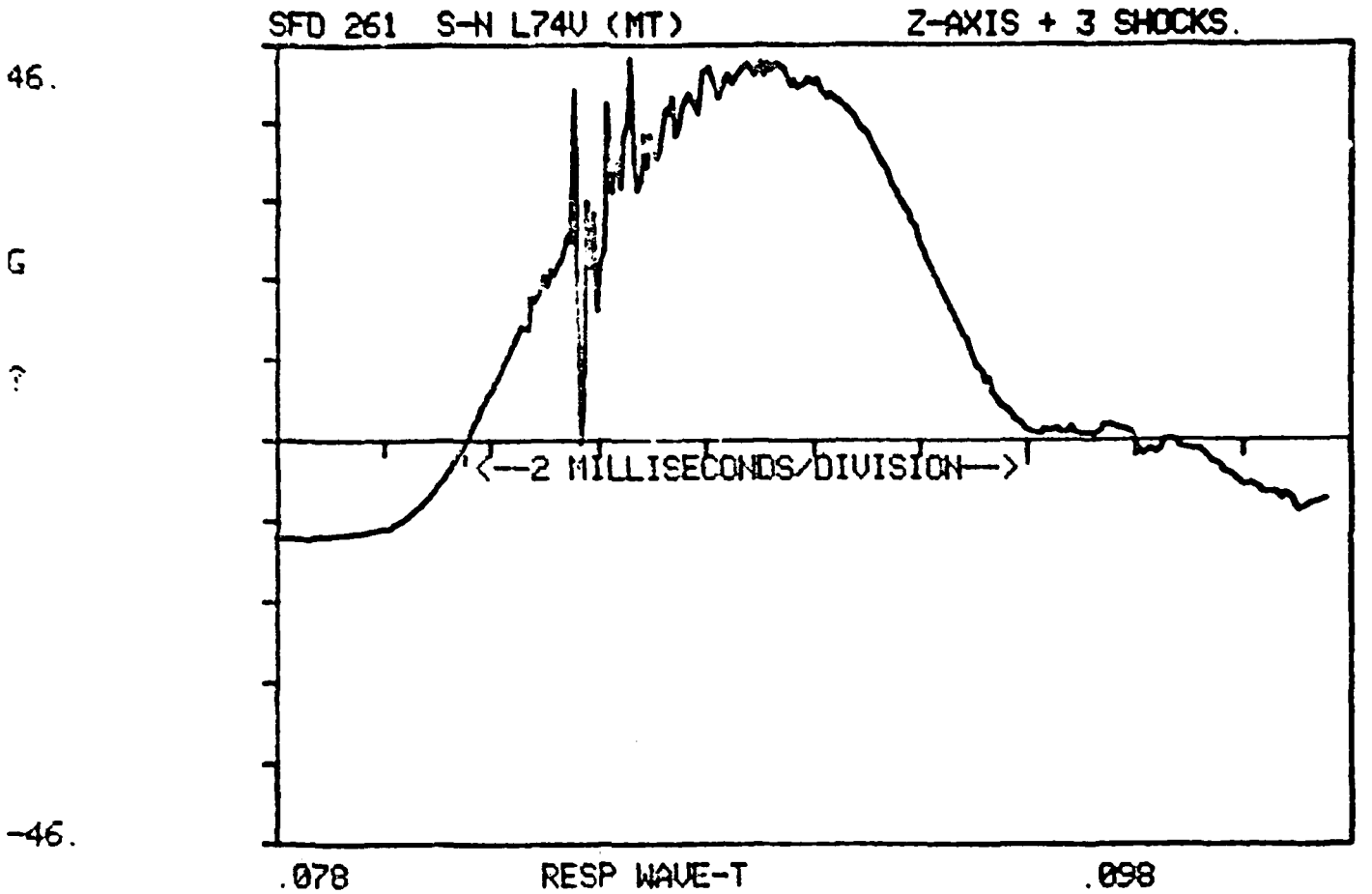
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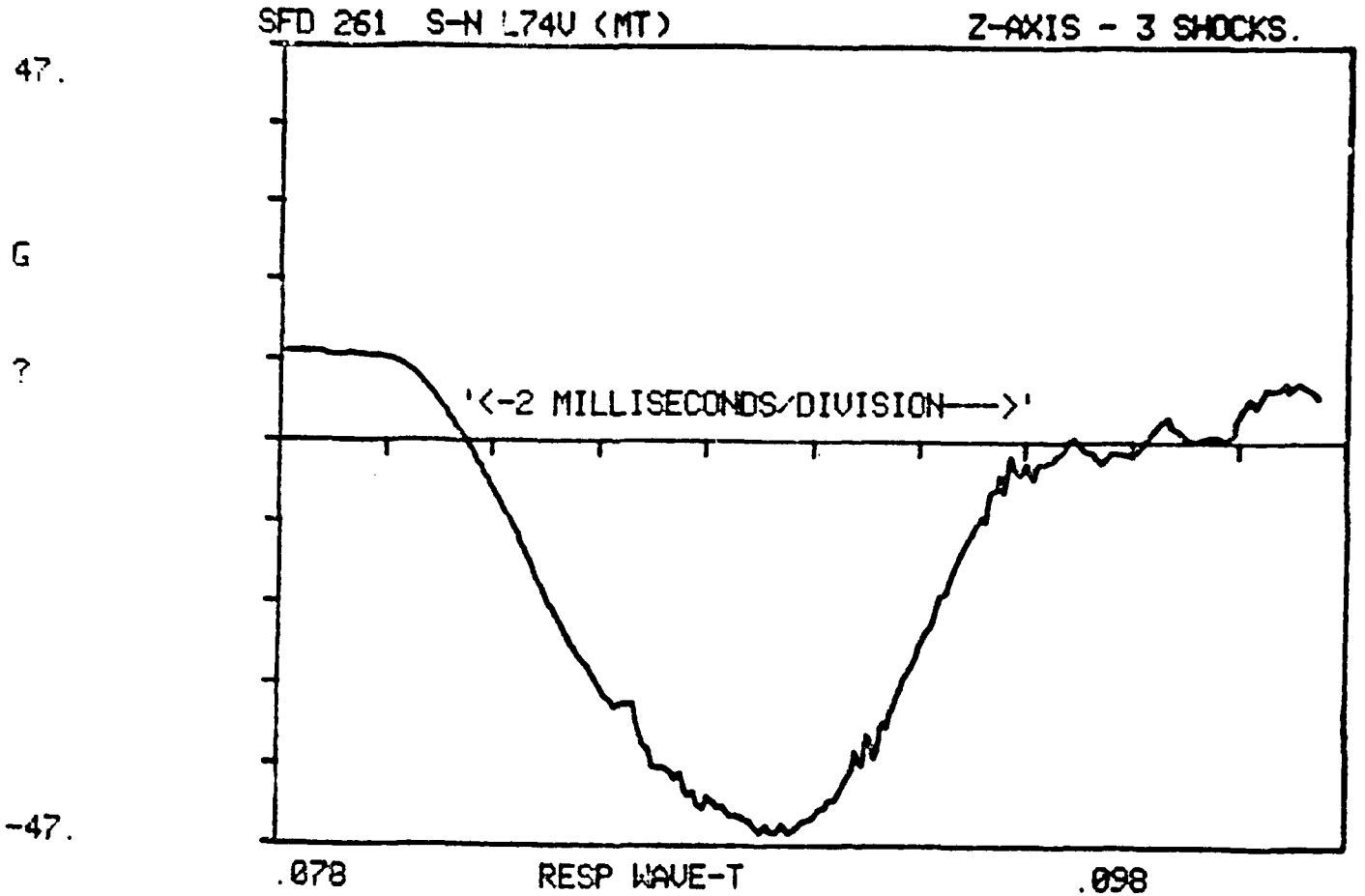
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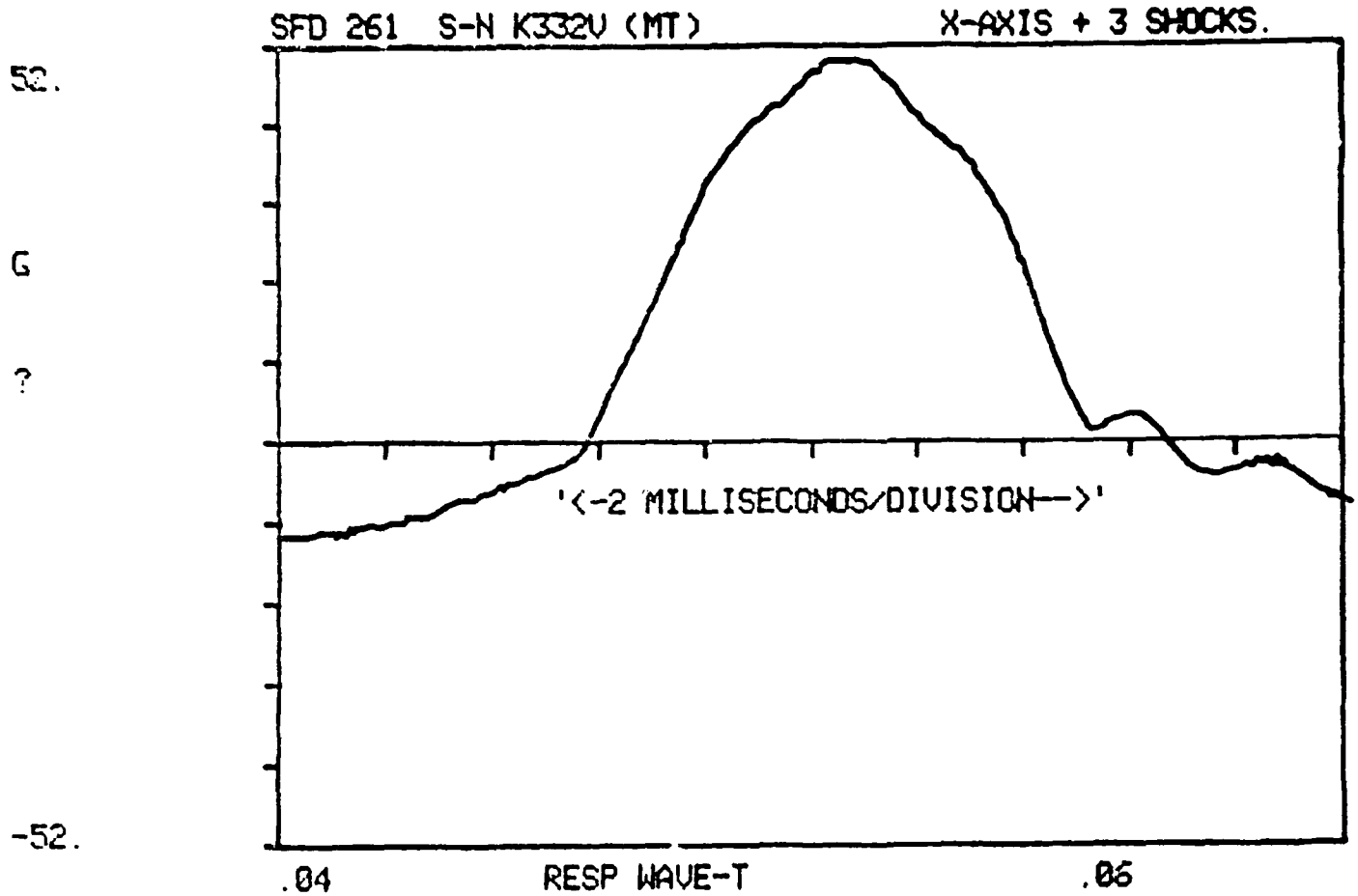
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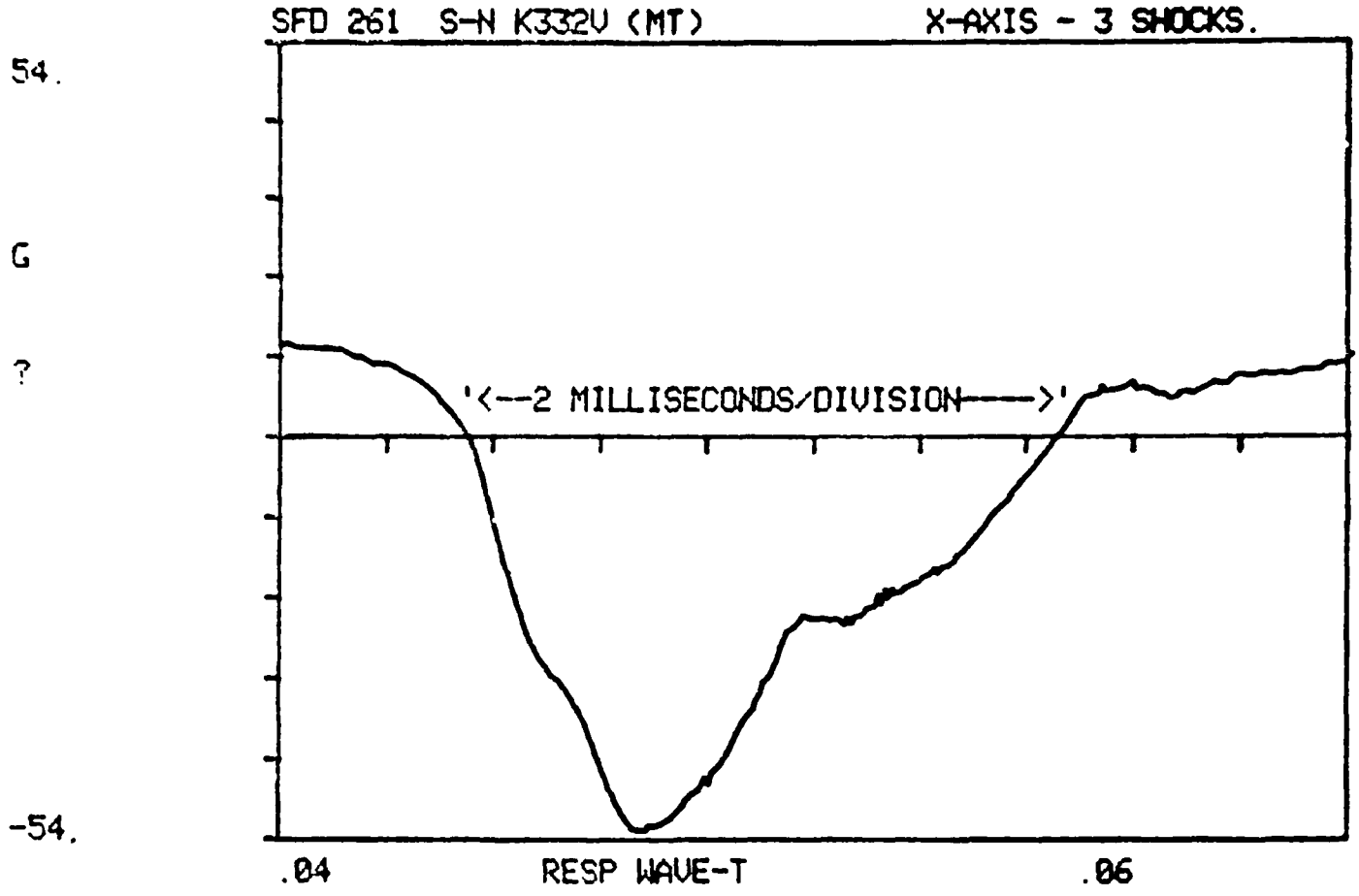
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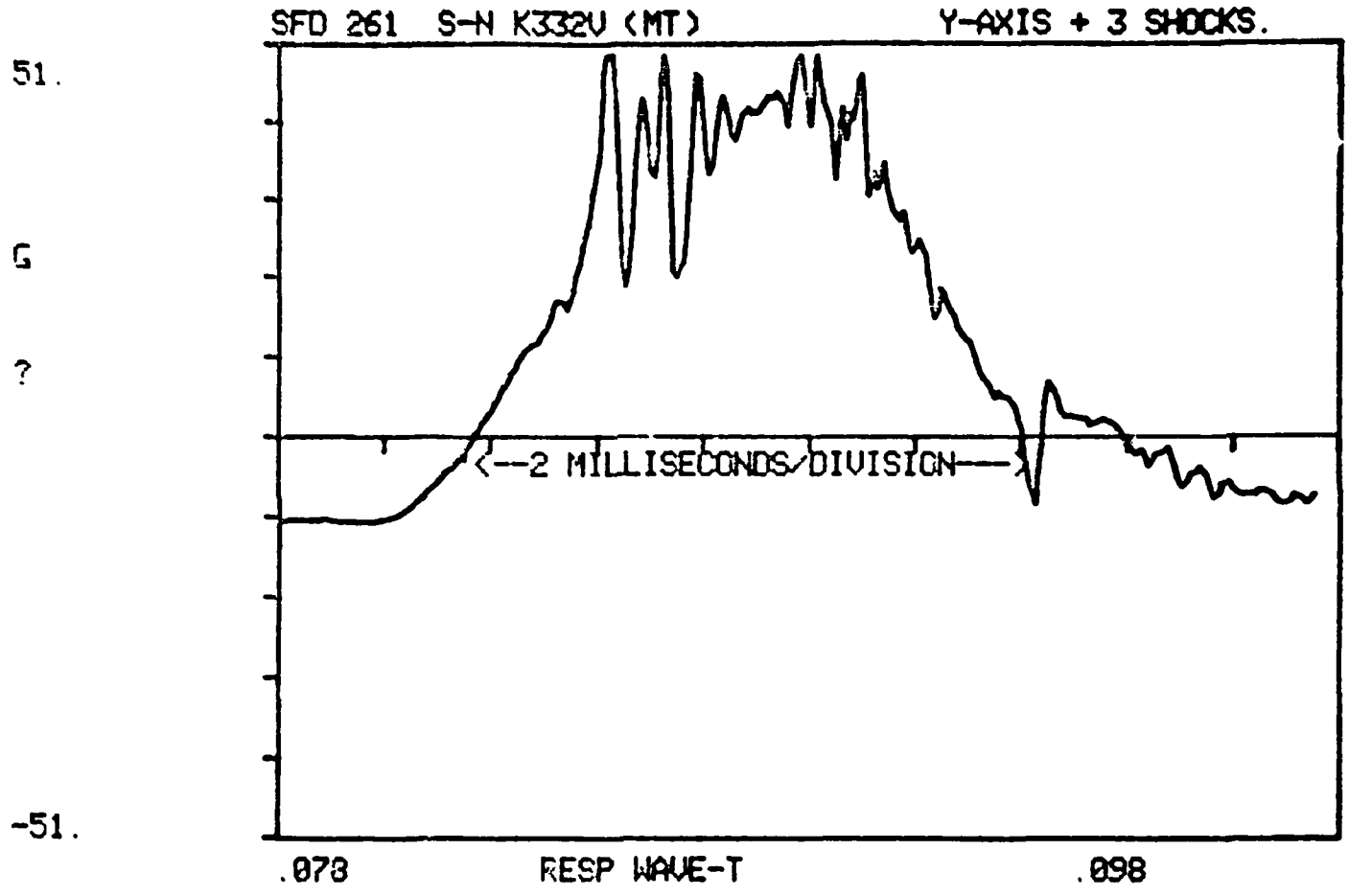
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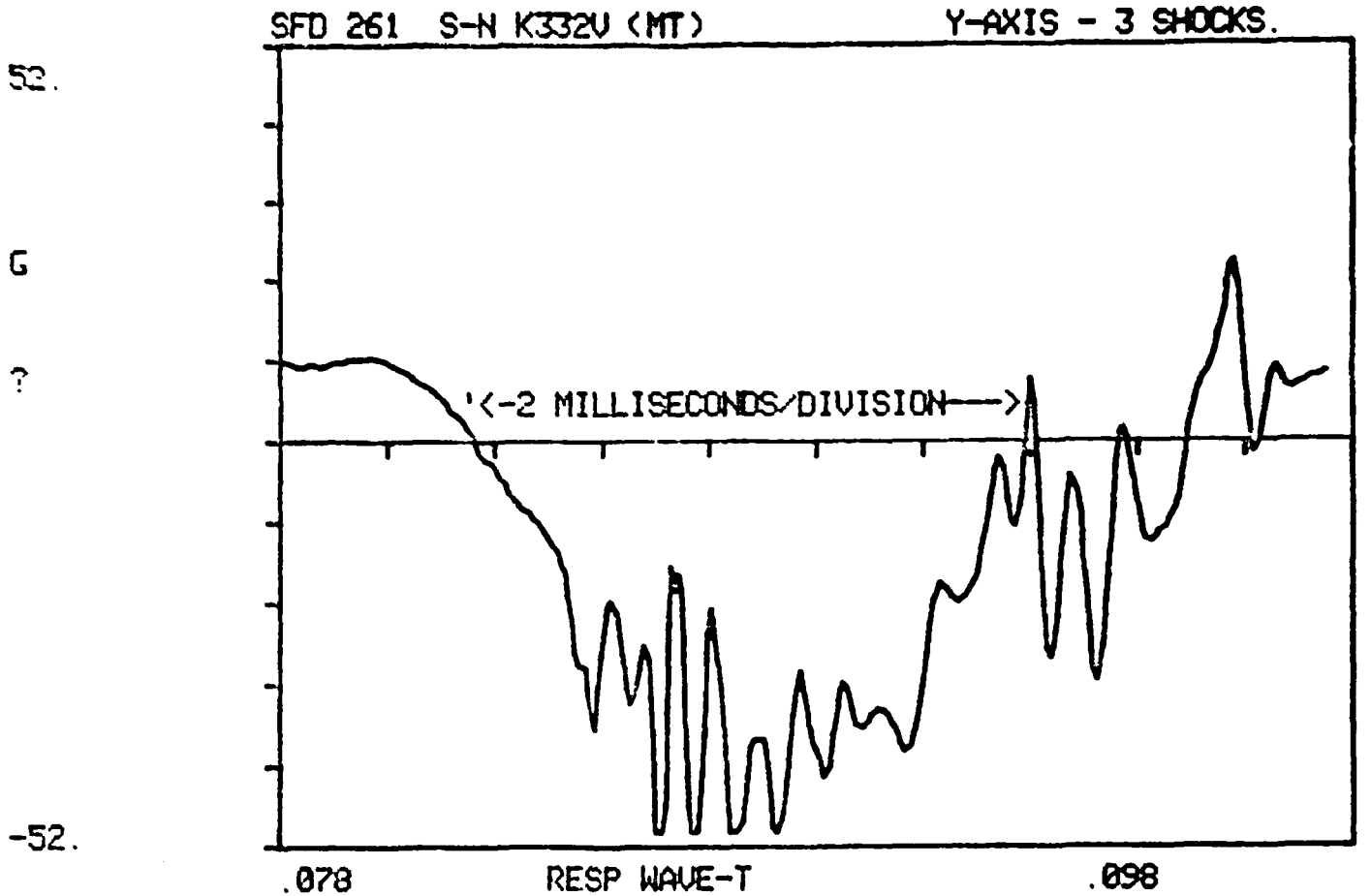
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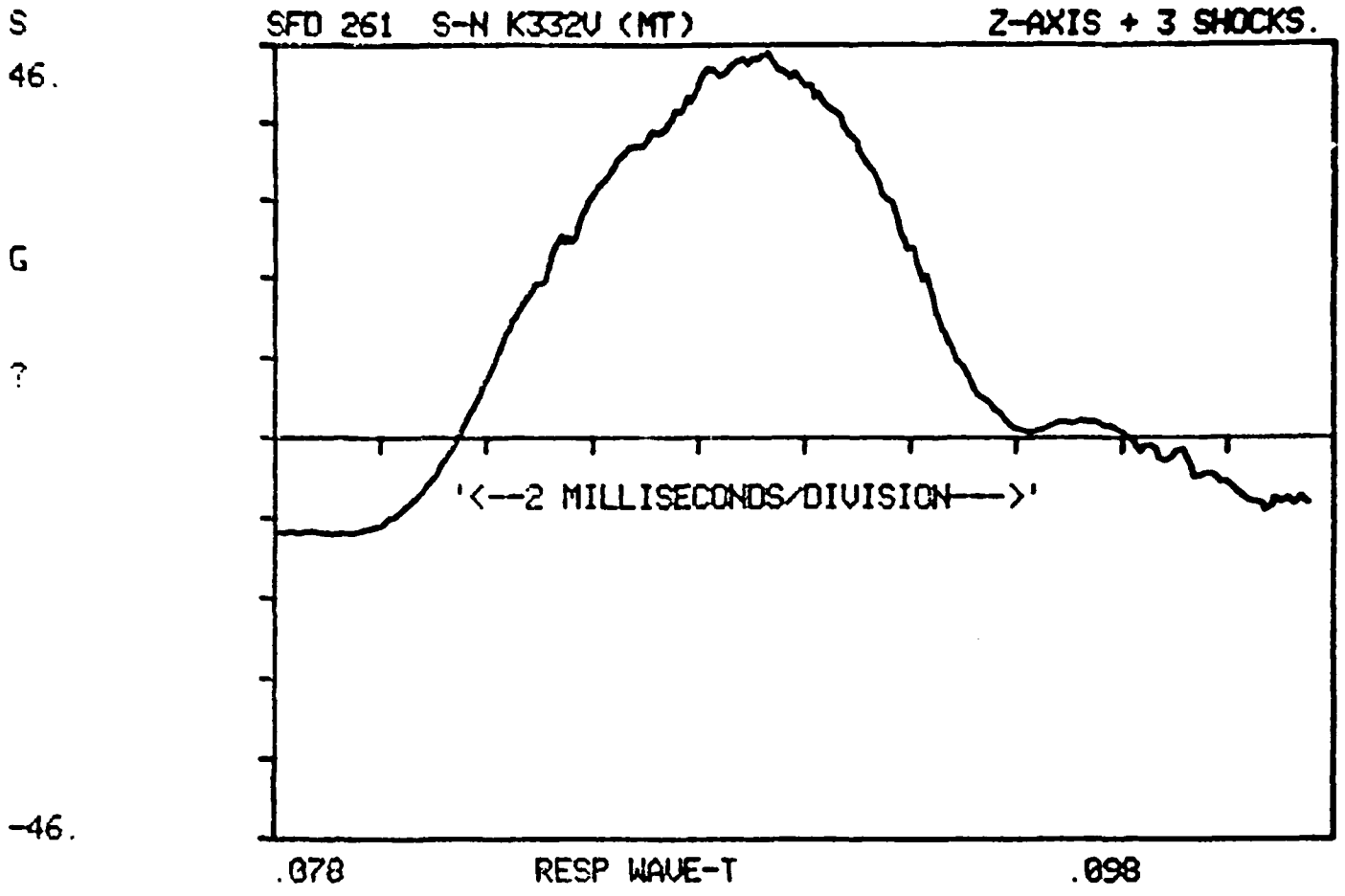
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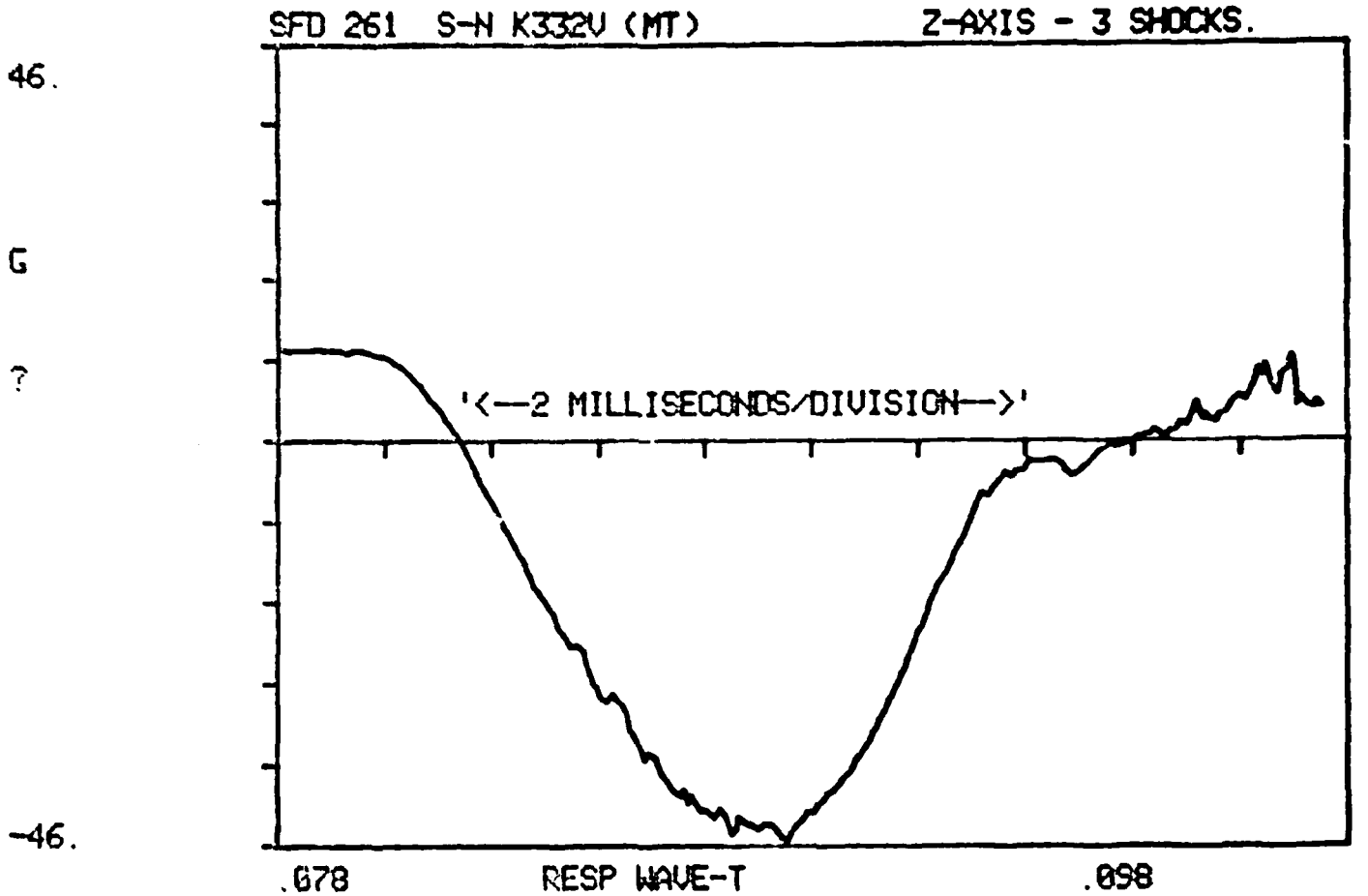
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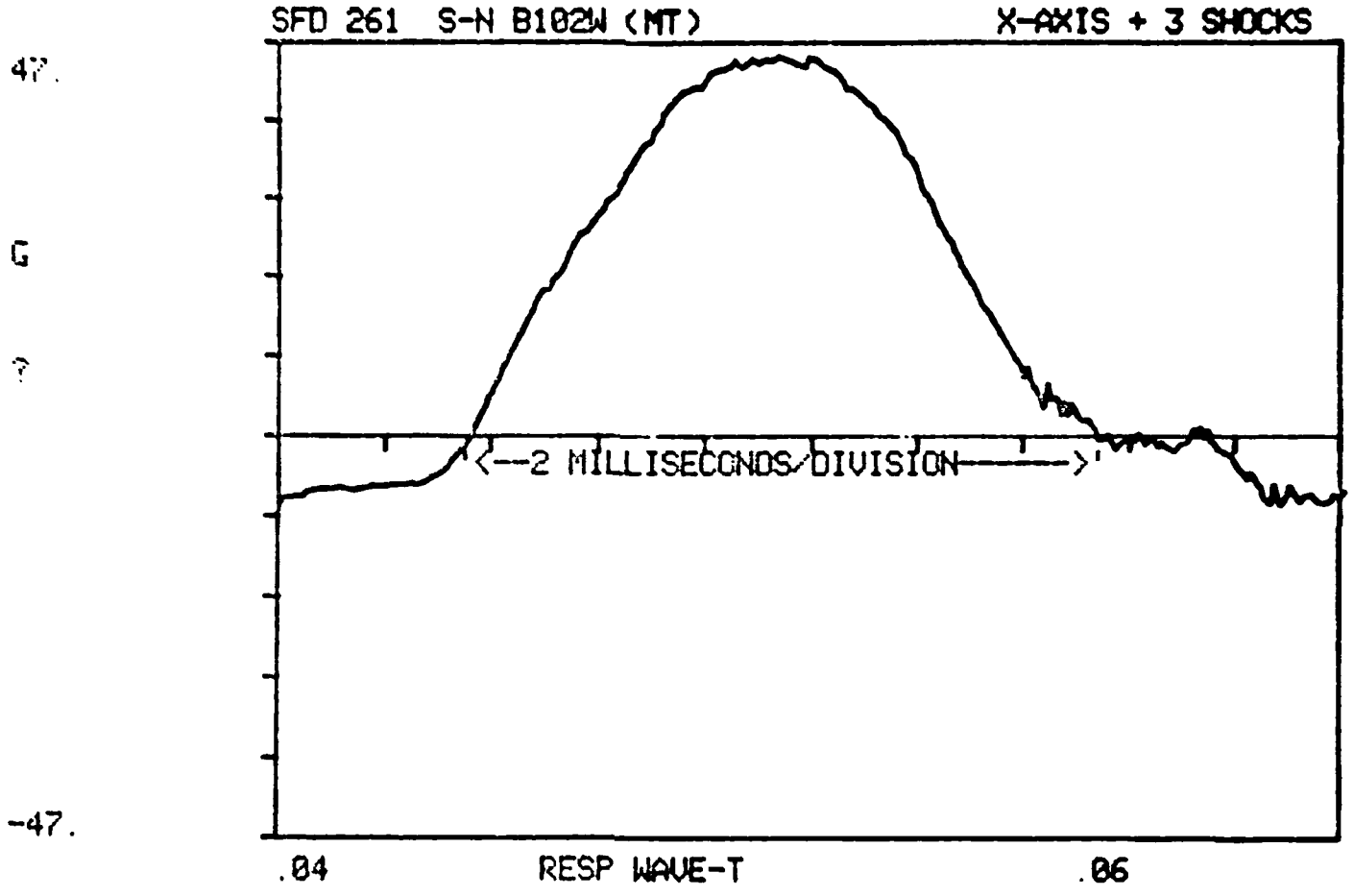
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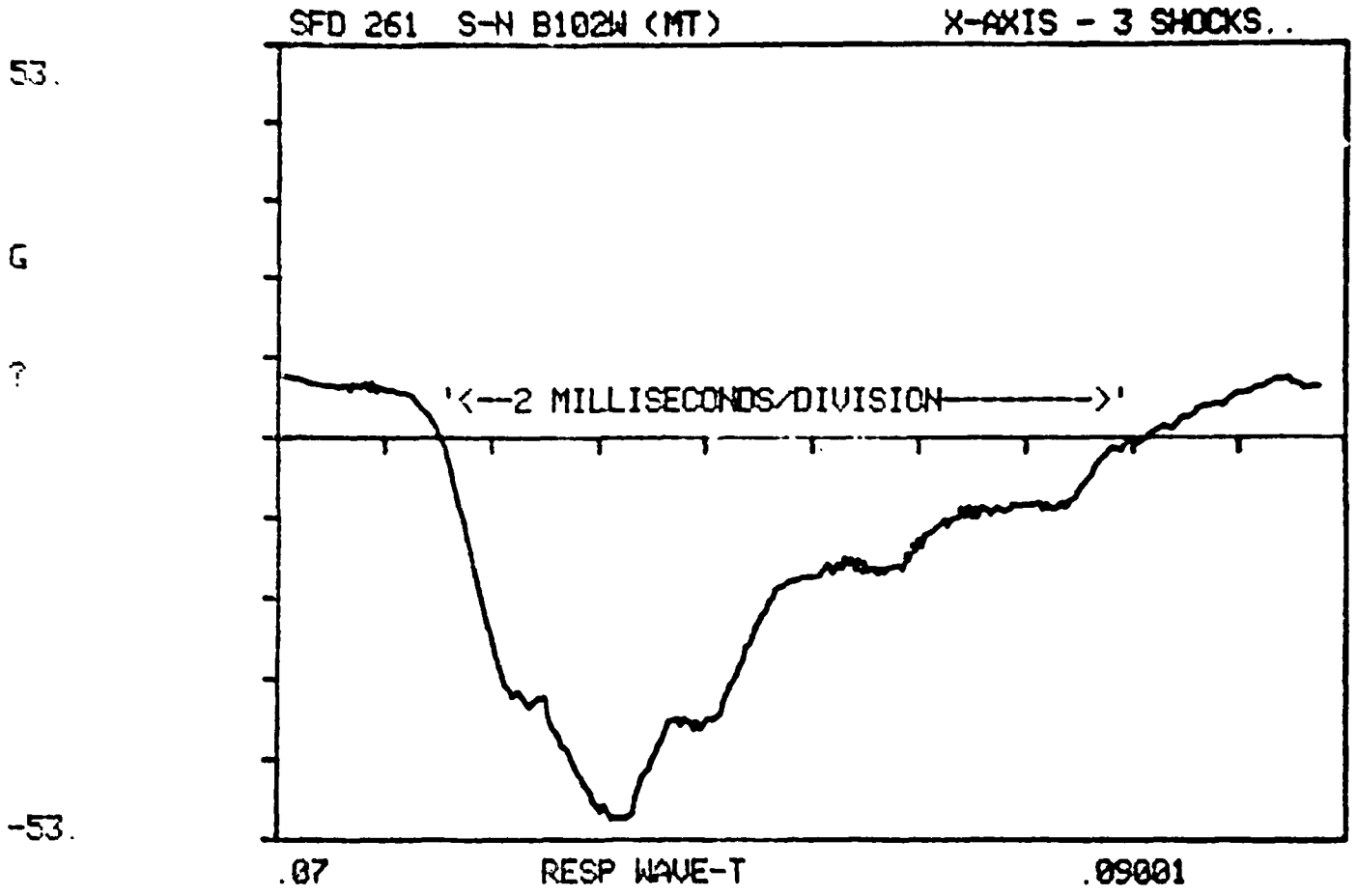
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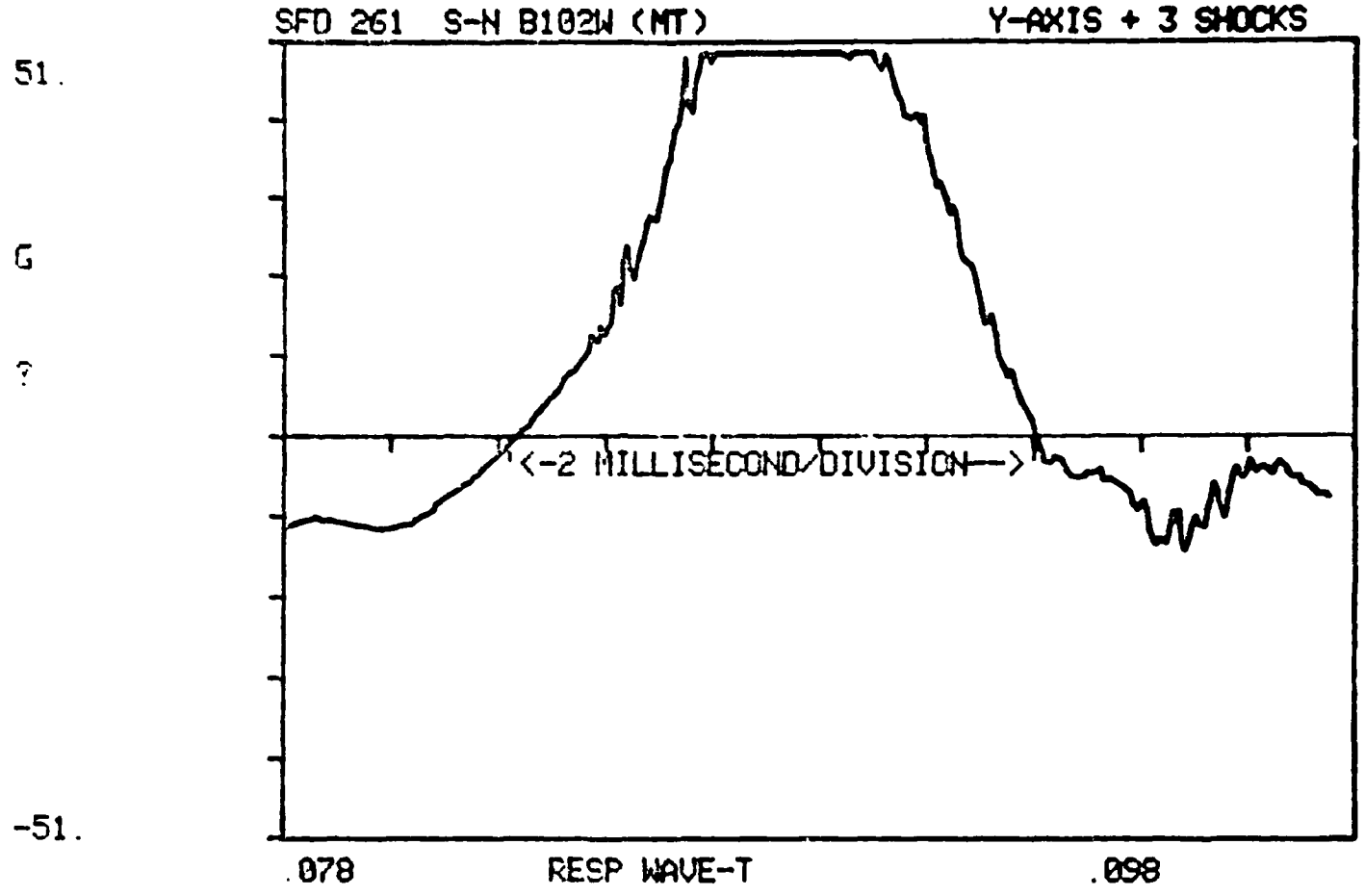
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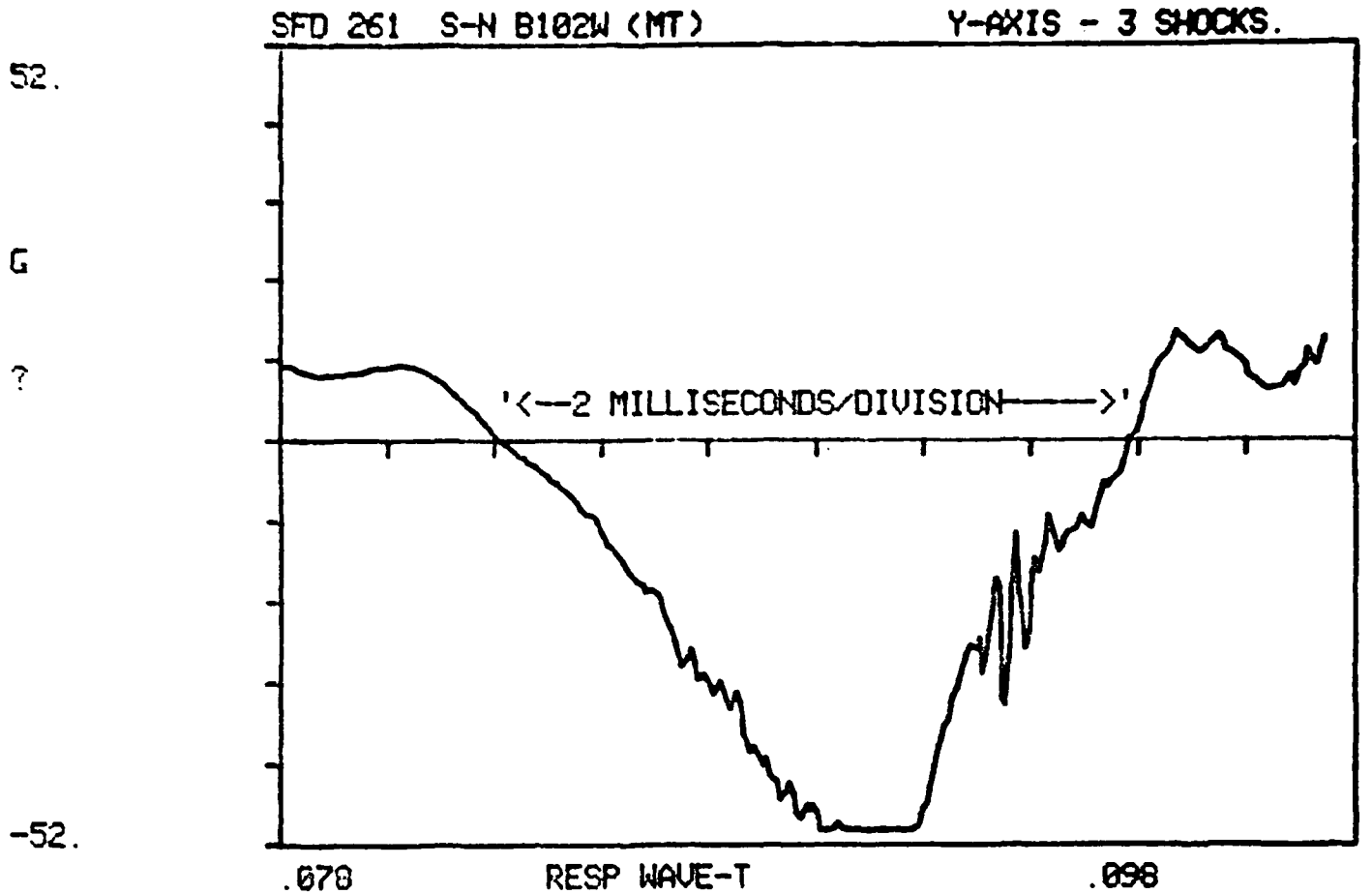
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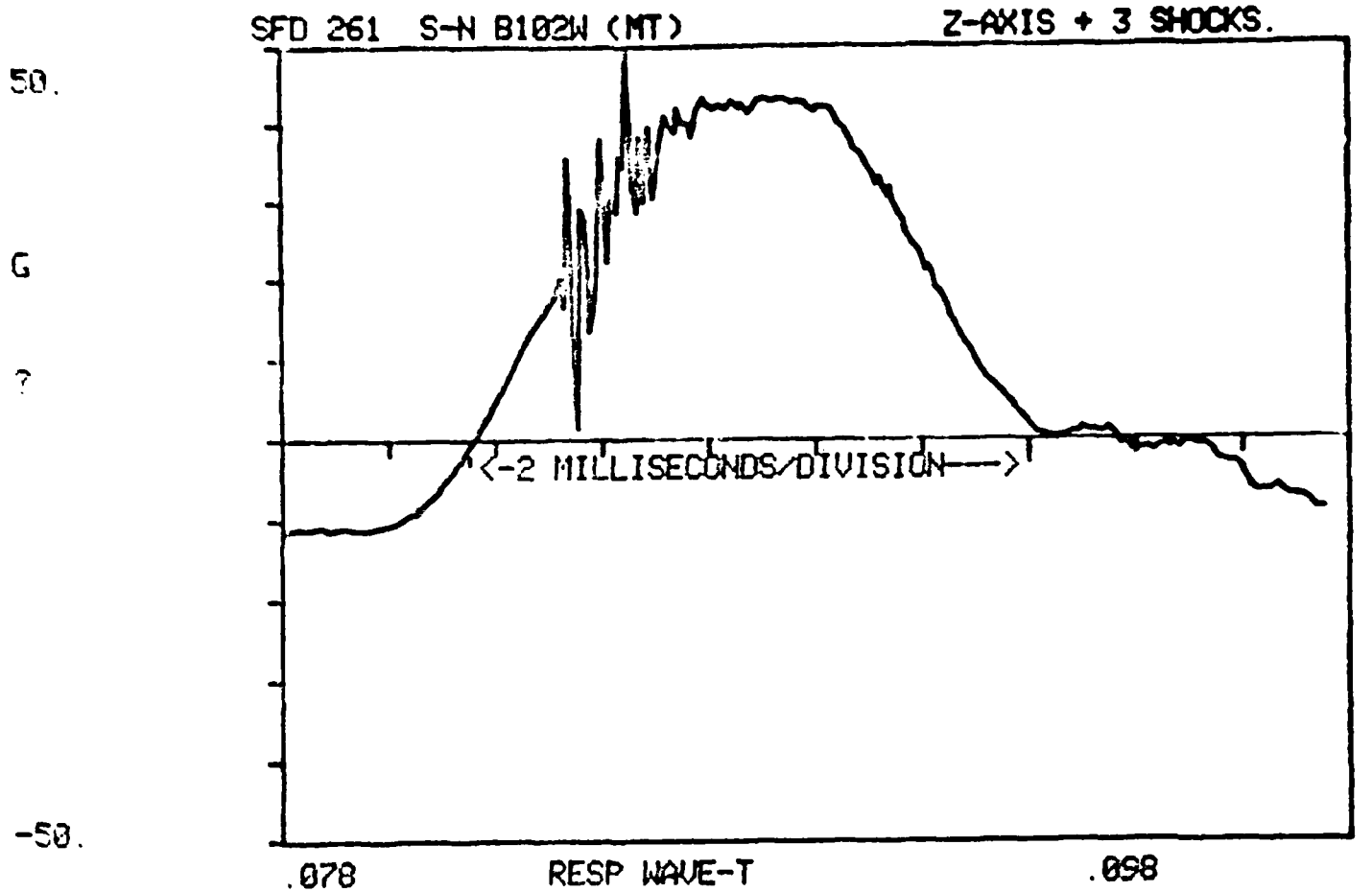
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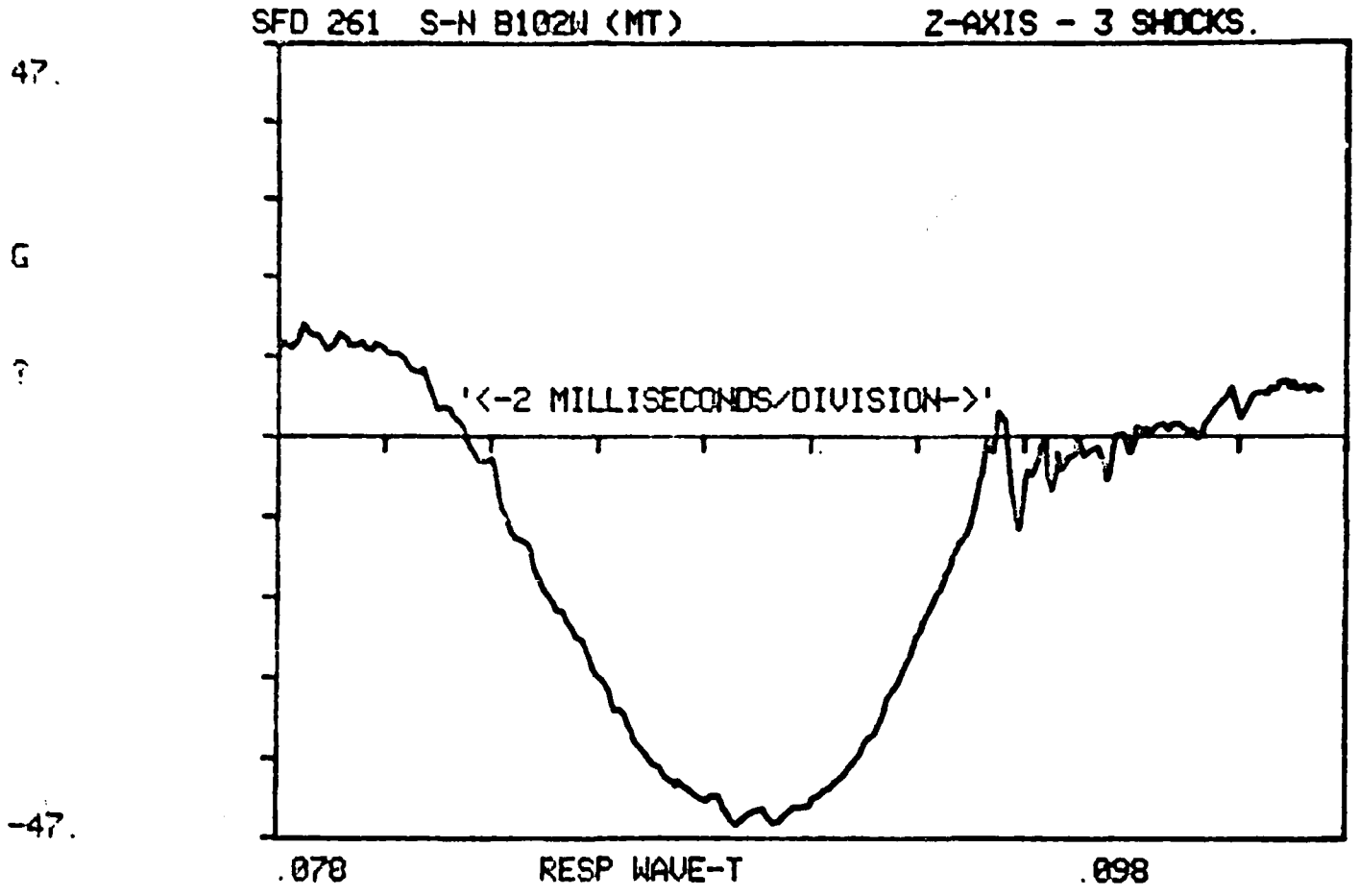
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